

DEVELOPMENT OF FIELD SURVEY SOFTWARE ON APPLE'S IPHONE AND IPAD FOR LAND USE AND LAND COVER APPLICATIONS

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ABSTRACT: The field survey data is very important for land use and land cover applications. Normally, a data collected at the field is linked with one geographical point, described by latitude and longitude. However, in many cases, the data collected at a point can be used for the region surrounding that point. This study develops an application on Apple's iPhone and iPad, which can help users to collect the field data for both points and regions. With this application, user can select the point or draw the polygon of the region of interest on the map, take a photo, gather the information which is necessary for land use and land cover application such as land cover type, the species, height, crown width, diameter breath height... of the forested and non-forested categories at the field, and save the collected data on the device. The user can also share the collected data with other users by uploading those data to the server. The data collected by this application have been used to generate and validate the land cover map of Vietnam, Laos and Myanmar.

1. INTRODUCTION

In land use and land cover applications, field survey database always plays a very important role. The field survey data is one of the key inputs for design and training the algorithms. This data also is the vital references for verifying the result of land use and land cover. There are a lot of field survey databases existing. Most of the land use and land cover projects have their own field survey databases. However, these databases are either closed to the people working outside those projects or not well organized as a database to be effectively accessed by the computer software. There are also the open geographical data sources on the Internet such as GeoNames (GeoNames, 2007) and Alexandria (Alexandria, 2004). Although these data sources are well organized to be used by computer software, they are mainly updated by the normal users, who are not professional in land use and land cover study, and therefore the data are sometimes not correct (Popescu, A. et al., 2009) (Ling Y., 2003) (Greg J. et al., 2004). Consequently, the available field survey data sources are not always able to be used by land use and land cover applications.

GPS Photos Database was introduced (Van and Takeuchi, 2010) to convert the existing field survey data to a better database for land user land cover applications. The database was built up based on not only the existing data at the research institutions but also the newly collected field survey data. Each item in the database includes the photo of the region of interest together with the corresponding location information, land cover types, object descriptions and other relating information. This database has been using for the land cover classification projects in Vietnam, Laos and Myanmar.

In order to provide a tool to conduct field studies, a GPS Photos Database management application and an interface between user and the database, we developed Field Survey software on Apple's mobile devices, iPhone and iPad. With Field Survey software, user can easily manage the database from the mobile devices. During the field survey, surveyors will enter data directly into the mobile devices. On-site data can be uploaded to the server and shared with other users. The rapid entry of on-site data will allow scientists to optimize collection efforts and accelerate the progress of the field survey. The portability processing power of iPhone and iPad makes them ideal tools for processing data and conducting field studies

2. SOFTWARE REQUIREMENTS AND DEVICE

2.1 Software requirements

Field Survey software has three main requirements: to be a tool for field studies, to manage GPS Photos Database and to be the interface between users and GPS Photos Database. Figure 1 shows how the Field Survey software works. As the tools to conduct field studies, Field Survey software helps user to collect data such as taking photo, getting location information and storing data. As a database management application, Field Survey software should display the data from the database, allow user to add new data to the database, edit the existing data and remove the

data from the database. User can be able to upload data to or download data from the server when the device connects to the Internet. As the interface between the GPS Photos Database and user, Field Survey data can receive the requests from user, process and send back the result in the properly format, and share the data between users.

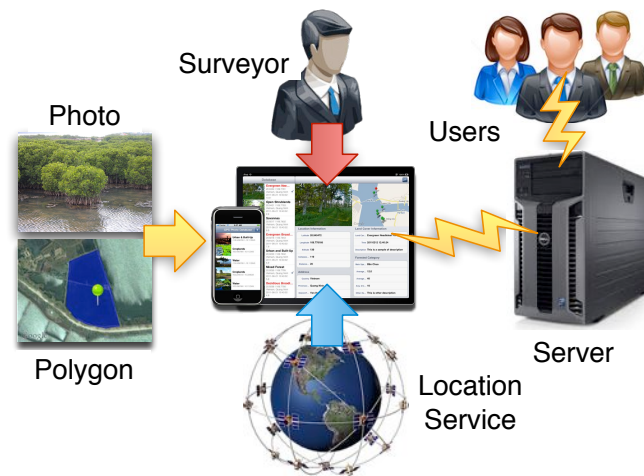


Figure 1. The implementation of Field Survey software on Apple's iPad and iPhone

2.2 Devices

Today's mobile device not only serves as the key computing and communication mobile device of choice, but it also comes with a rich set of embedded sensors, such as an accelerometer, digital compass, gyroscope, GPS, and camera (Lane N.D et al., 2010). These capabilities of the mobile device are more important in the field studies, in which the surveyors have to move across the rough terrains to collect data. For this reason, mobile devices become the first priority for surveyors when selecting the devices to work with.

In this study, we selected iPhone and iPad of Apple as the devices to develop software (Apple, 2010a)(Apple, 2010b). First, iPhone and iPad include touch screen. The touch screen allows user to interact with the device directly and quickly. Second, these devices include many sensors such as a gyroscope, compass, accelerometer, proximity sensor, as well as other more conventional devices that can be used to sense such as front and back facing cameras, GPS and WiFi and 3G network connectivity. The GPS, which allows the phone to localize itself, enables new location-based applications such as local search, mobile social networks, and navigation with 10-meter precision. The compass and gyroscope represent an extension of location, providing the device with increased awareness of its position in relation to the physical world enhancing location-based applications. These sensors make the devices ideal sensing tools at the field. Third, iPhone and iPad are programmable with computing and communication resources that offer the application of third-party programmers. Forth, a lot of people are using iPhone and iPad, this is the big advantage to spread the software to users.

3. FEATURES OF FIELD SURVEY SOFTWARE

In order to meet all the requirements mentioned above, the features of Field Survey software is tightly associated with the structure of the GPS Photos Database. This section will explain the structure of GPS Photos Database and describe the features of Field Survey software in the way it displays information, how user update the database and which information user can extract from the database.

3.1 GPS Photos Database

In this study, Filed Survey software uses SQLite, the free library of database management engine (SQLite Team, 2010), to manage GPS Photos Database. Used in countless applications across many platforms, SQLite is considered a de facto industry standard for lightweight embedded SQL database programming. Unlike the object-oriented Core Data framework, SQLite uses a procedural, SQL-focused API to manipulate the data tables directly. This database management engine was integrated in the operation system of iPhone and iPad.

Every item in the GPS Photo Database contains the information about one place of interest. This information is divided into 4 categories: location information, land cover type, object description, and environment data. Figure 2 is an example of the detail information about the place of interest on iPad and iPhone. Location information includes the latitude, longitude, altitude and the postal address of the place of interest. Land cover type shows the

land cover type of the place of interest at the time data is collected. Because the land cover definition depends on the user, organization or country, GPS Photos Database allows user to define an object in 3 different definitions. One of the default land cover classification definition is International Geosphere-Biosphere Programme, which includes 17 land cover classes (IGBP, 2006). The object description includes the information about the main species, the status of the plant and other information including average height, average diameter, and average crown diameter. The environment data allows user to store the air and soil temperature, relative air humidity, wind speed and volumetric water content.

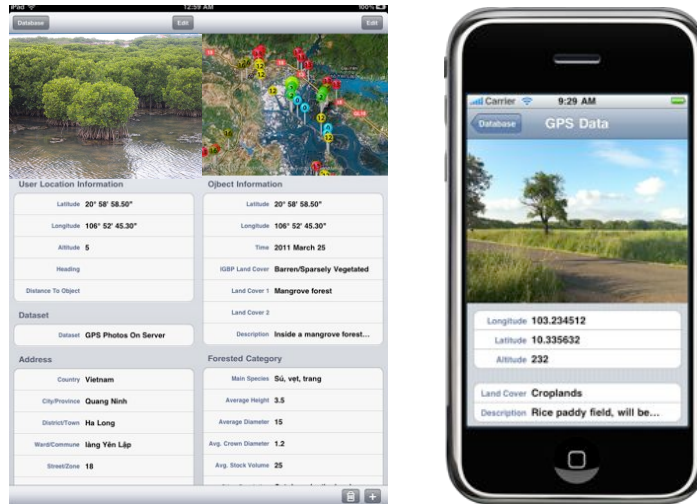


Figure 2. Detail information about the place of interest on iPad (left) and iPhone (right)

3.2 Display information

In Field Survey software, the database is displayed in two view modes: map view mode and detail view mode. Figure 3 is the map view mode and Figure 4 is the detail view mode of a database on iPad. The map view mode shows the data on a map, which provides the traditional view to the user. Each item in the database is displayed as an annotation with corresponding classification identifier. User can select an annotation to get the detail information about the corresponding item. Field Survey software also let user overlay the custom maps in the map view mode. In Figure 3, the land cover map on ALOS AVNIR2 data of Khammouane province, Laos, was overlaid with the annotations of visited places.

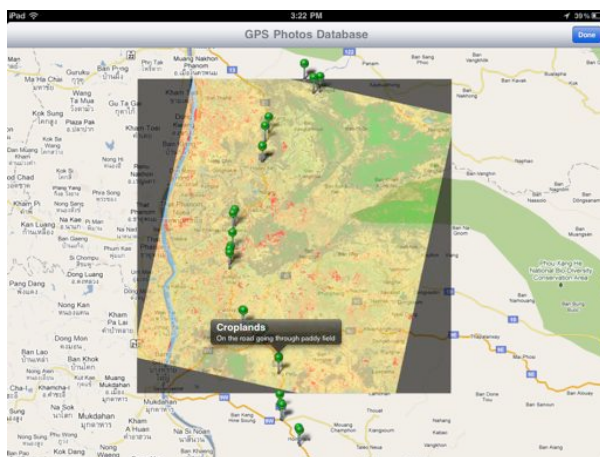


Figure 3. Map view mode on iPad

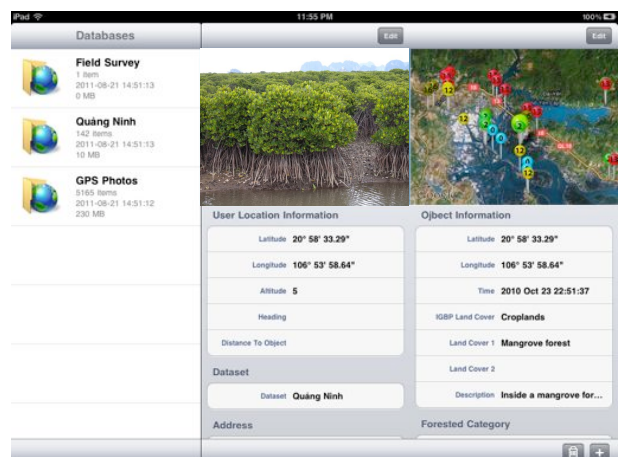


Figure 4. Detail view mode on iPad

The detail view mode displays the data for every item in the database. This view mode presents the data with a photo, a map and the tables. In this view mode, user can change the photo, relocate the positions of the object of interest, modify the polygon representing the place of interest, and edit all other relating information. Figure 5 shows the interfaces on iPhone, in which user is editing the data in the detail view. User can change the values of latitude, longitude and altitude as shown in figure 5c, select land cover type like figure 5d, and make description as in figure 5e.



Figure 5. Editing data on iPhone

3.3 Update the database

Figure 1 expressed the flow chart of database updating. First, user uses the built-in camera of the device to take the photo the place of interest. After user taking the photo, the software automatically retrieves the current latitude, longitude and altitude values. The GPS location service inside the device can locate the location of user with 10-meter precision. The location information is also automatically decoded to get the postal address of the place of interest. At the next step, user uses touch screen to specify the position of the object in the photo, and input other information of the place of interest. Finally, when the device is connected to Internet, user can upload the data to the server and share with other users. Figure 6 shows the user's position (small blue annotation) and object's position (big green annotation) on the field. After taking photo, user touches on the map to specify the object's position.

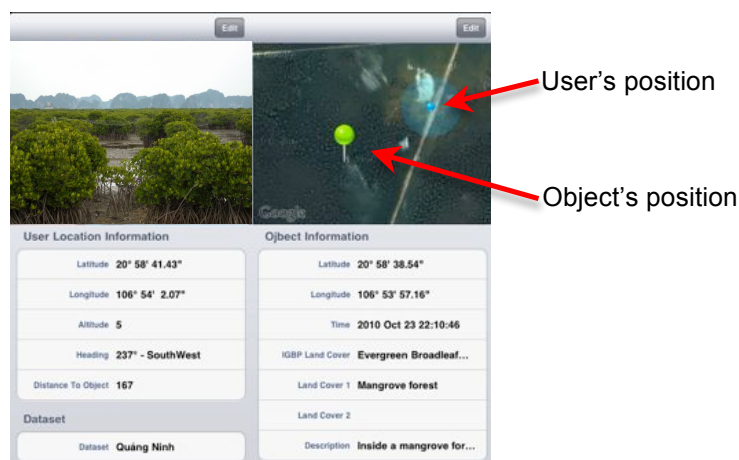


Figure 6. Specifying the object's position on map

Normally, user collects the data for one geographical point whose position is specified by latitude and longitude. However, in many situations, all the points in a same region share the same data, it means that the data of a position can be used for all the points inside that region. For example, in the mangrove forest shown in Figure 7, all the mangrove trees are the same; therefore, the data collected for one position can be used for all other positions in this forest region. In this case, user can update the data for the whole region by selecting a polygon which represents the region of interest and update data for it. Figure 8 shows the update with polygon feature. After selecting the polygon on the map, user can edit the relating information of that region as he does when updating the information for a new photo.

3.3 Searching and extracting information

As the interface between the GPS Photo Database and the user, Field Survey software provides data based on the user's requests. User can search for the items in a certain region, which is specified by the distance from a center position or by the name of the region. User can also search for the items based on the time they are collected, or

based on the land cover type of the items. Figure 9 shows the place within 30 kilometers from the position (N20°58'48", E106°54'5"), in Quang Ninh province, Vietnam. The result of a search can be save as a new database so that user can work only with the items he searched for.



Figure 7. A homogenous mangrove forest

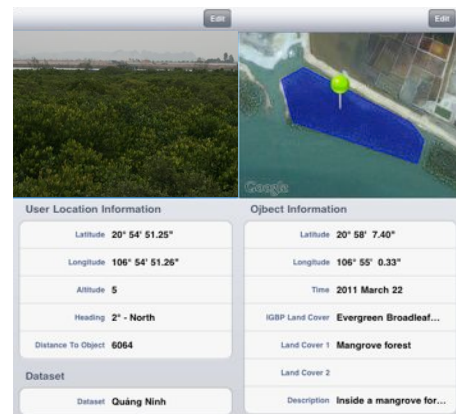


Figure 8. Update data with polygon

Another important feature of the Filed Survey software is data extraction. The data in the database or the result of a search can be extracted in some formats. Data can be extracted in text format to be used by other software. Data can also be represented in the Google's KML (Google, 2011) and ESRI's Shapefile formats, which can be used in Google Earth and ArcGIS. Furthermore, the detail information about an item can be provided to the user in the format of a report. Figure 10 is the database presented in Google's KML format.

Finally, Field Survey software can synchronize the database on the mobile device with the database on the server. This feature enables users to share the field data. Whenever a mobile device connects to the server, all the change on that mobile device and on the server will be synchronized.



Figure 9. Items within 30 kilometers from the center point



Figure 10. Database in KML format

4. CONCLUSION

This study developed the Field Survey software running on Apple's iPhone and iPad to serve as a tool to conduct field studies, as the GPS Photos Database management and as the interface between GPS Photos Database and the user. As the tool to conduct field studies, Field Survey software allows user to take photo, select the point and polygon of the place of interest, get the location information and store on mobile device. As the database management, Field Survey software allows user to easily and quickly manage the database from the mobile device. As the interface between GPS Photos Database and user, this software can reply the requests from user and extract the information in the format of text, KML or Shapefile. Field Survey software has been using for the land cover classification project in Vietnam, Laos and Myanmar. In the future, more features will be integrated and the software will be developed to run on other mobile operating systems such as Android and Windows Phone.

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